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ABSTRACT

This study investigated the effects of presenting future target behaviors in the consequent event following correct responses of current target behaviors when teaching five preschoolers with developmental delays to name numerals. A 3-second constant time delay procedure was used to train two sets of numerals. During instruction, correct responses to one set of numerals received a token, verbal praise, and presentation of the printed number word for the targeted numeral in one daily session. In the other daily session, the second set of numerals received only tokens and verbal praise. After the criterion was met on both sets of numerals, children received instruction on number words corresponding to numerals in each of the previously instructed sets. An adapted alternating treatments design was used to compare the effectiveness and efficiency of the two conditions. Results indicate that: (a) all children learned to name numerals in both conditions; (b) presentation of future target behaviors did not interfere with learning of numerals; (c) four of five children learned to read all number words in both conditions; and (d) the addition of number words during numeral instruction increased the rapidity with which children acquired the number words. (Contains 31 references.) (Author/CR)

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# Increasing the Efficiency of Future Learning through Instructive Feedback

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## Abstract

This study investigated the effects of presenting future target behaviors in the consequent event following correct responses of current target behaviors when teaching preschoolers in a small group arrangement to name numerals. A 3-second constant time delay procedure was used to train two sets of numerals. During instruction, correct responses to one set of numerals received a token, verbal praise, and presentation of the printed number word for the targeted numeral in one daily session. In the other daily session, the second set of numerals received only tokens and verbal praise. After criterion was met on both sets of numerals, children received instruction on number words corresponding to numerals in each of the previously instructed sets. An adapted alternating treatments design (Sindelar, Rosenberg, & Wilson, 1985) was used to compare the effectiveness and efficiency of the two conditions. Results indicate that (a) all children learned to name numerals in both conditions, (b) presentation of future target behaviors did not interfere with learning of numerals, (c) four of five children learned to read all number words in both conditions, and (d) the addition of number words during numeral instruction increased the rapidity with which children acquired the number words.

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## Increasing the Efficiency of Future Learning by Manipulating Current Instruction

Teachers of individuals with developmental delays and disabilities have a number of instructional strategies from which to choose. These include the system of least prompts (Doyle, Wolery, Ault, & Gast, 1988), progressive time delay (Charlop & Trasowech, 1991), constant time delay (Wolery, Holcombe, et al., in press), simultaneous prompting (Schuster, Griffen, & Wolery, in press), most-to-least prompting (McDonnell & Ferguson, 1990), peer-mediated strategies (Kohler & Strain, 1990), incidental teaching and other milieu strategies (Kaiser, Yoder, & Keetz, 1992), and the task-demonstration-model procedure (Repp, Karsh, & Lenz, 1990). A considerable amount of research documents that these strategies result in students of varying ages and with a wide range of disabilities learning a broad array of useful skills (Wolery, Ault, & Doyle, 1992). Based on these encouraging findings, recent research has attempted to move the analysis of instruction beyond demonstrations of effectiveness.

This research has focused on several separate but related dimensions of instruction. Some investigations have compared two or more strategies directly in terms of the rapidity with which learning occurs (i.e., sessions, trials, and minutes of instruction to criterion) (Ault, Wolery, Doyle, & Gast, 1989). Other studies have evaluated the effects of group instruction to make more efficient use of teacher time and promote opportunities for observational learning (Schepis, Reid, & Fitzgerald, 1987; Farmer, Gast, Wolery, & Winterling, 1991). Still other studies have evaluated the effects of choral versus individual responding (Wolery, Ault, Doyle, Gast, & Griffen, in press), predictable versus unpredictable orders of trial presentation (Ault, Wolery, Gast, Doyle, & Martin, 1990), interspersal of trials on known skills during instruction on new skills (Koegel & Koegel, 1986), and attentional cues (Wolery, Cybriwsky, Gast, & Boyle-Gast, 1991; Wolery, Ault, Gast, Doyle, & Mills, 1990).

In addition to this research, a number of studies have evaluated the effects of instructive feedback, which involves the presentation of additional, non-target stimuli to the consequent events (e.g., praise statements) following students' responses. In these studies, the student is presented with the target stimulus and given an opportunity to respond. After a correct response, reinforcement plus an additional, non-target stimulus is presented. Students are not required to respond to this additional stimulus. For example, when teaching a student to read a sight word, the definition of the word would be presented during teacher praise for correct responses. Instructive feedback has been effective with secondary students with moderate mental retardation (Doyle, Gast, Wolery, Ault, & Farmer, 1990) and learning and behavioral disabilities (Wolery, Cybriwsky, et al., 1991), elementary students with mild (Shelton, Gast, Wolery, & Winterling, 1991) and moderate mental retardation (Stinson, Gast, Wolery, & Collins, 1991), and preschoolers with mental retardation (Wolery, Holcombe, Werts, & Cipollone, in press). The additional stimuli have been presented verbally (Doyle et al., 1990), on a computer screen (Edwards, 1989), and verbally accompanied by a visual display on a flash card (Gast, Doyle, Wolery, Ault, & Baklarz, 1991). In each of these studies, students learned the behaviors that were taught directly and some of the additional stimuli that were presented but not taught directly.

One study evaluated the effects of instructive feedback during initial instruction on students' learning in later instruction (Wolery, Doyle, et al., 1991). Initially, students were probed on their ability to name two sets of photographs and read words of the entity depicted in those photographs. The students were then taught to name the two sets of photographs during separate, daily sessions. One set of photographs was taught without instructive feedback; and the second set was taught with instructive feedback which involved showing a flash card with a written word of the entity depicted in the photograph. After students achieved criterion level performance on photograph naming, they were assessed on their ability to name all photographs and read the written words. They were then taught (in separate daily sessions) to read the words for all photographs (i.e., those words they had been shown during previous instruction and those that corresponded with the photographs but had not been shown). The results suggested that adding the written word to the consequent events during photograph-naming instruction was an effective means of increasing the efficiency of future instruction when the words were taught directly.

However, this study had a number of limitations. First, progressive time delay was used. Progressive time delay is more complex than constant time delay, but studies directly comparing the two have shown minimal differences in the rapidity of learning (Precious, 1985; Ault, Gast, & Wolery, 1988). Generally, more parsimonious procedures should be used when learning is not differentially affected. Second, the students in this study had a history of direct instruction with naming pictures and reading words. This frequently is not the case with many young children. Third, the students were taught in one-to-one instruction. Such instruction is frequently impractical in schools and precludes the opportunity for observational learning. Fourth, students were only assessed on word reading for words that corresponded to the pictures taught. Thus, students may have "guessed" which words were identical rather than learned to read the words.

The purpose of the present study was to address these limitations. Constant time delay was used to teach preschoolers with developmental delays to name numerals and read number words. Two sets of numerals were taught first in separate daily sessions, and half the numerals were taught with instructive feedback (i.e., showing a flash card with the corresponding number word) and half were taught without instructive feedback. After criterion performance was established on numerals, the students were taught to read the number words that corresponded with all of the numerals. The students had no experience with constant time delay or instructive feedback, and none had received systematic instruction on the behaviors being taught. A small group format was used to evaluate the occurrence of observational learning. Also, words (called control words) with stimulus characteristics similar to the target words were used during probes to minimize the possibility of students' guessing the correct responses.

## Method

### Participants

Five preschool students participated in this study. Students had no prior experience with any direct instructional procedure. In addition, students had received no systematic

instruction on numerals or written words. Descriptive information of the students is presented in Table 1.

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Insert Table 1 about here

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All students met the following prerequisite skills: (a) ability to wait 4 seconds for a prompt when shown abstract line drawings and given the directions prior to the trial presentation, "If you don't know what the picture is, wait and I will tell you."; (b) ability to match to sample numerals when presented with a 3-choice array within 3 seconds of the task direction, "Which one is the same?"; (c) ability to match to sample number words when presented with a 3-choice array within 3 seconds of the task direction, "Which one is the same?"; (d) ability to imitate the instructor's verbal model within 3 seconds when provided with the task direction, "I want you to say the same thing that I say."; (e) intact auditory and visual systems required to see and hear all relevant stimuli as measured by direct observation of the student in circle time activities responding correctly to known questions and picture presentations; and (f) the ability to sit and attend to an instructor in the presence of two other children for 10 minutes.

Setting

This study was conducted in a preschool program for children with developmental delays. The classroom consisted of 8 children and 1 teacher. All experimental sessions for the two groups were conducted in the classroom at two tables designated for instructional activities. Screening, observational learning probes, and probe sessions were conducted in a one-to-one arrangement in the classroom by the investigator. The classroom teacher supervised all other children in the classroom while the investigator conducted the individual screening and probe sessions.

All instructional sessions were conducted in a group arrangement. The classroom teacher conducted instructional sessions with Group A (Eric, Chris, and Scott), and the investigator conducted instructional sessions with Group B (Paul and Jason). Both groups received two instructional sessions a day. During any session there was never more than three students in the classroom who were not participating in the study. These students were engaged in typical classroom activities.

Materials

Instructional materials consisted of sets of white index cards (4 in x 6 in) with a numeral printed 1 in. in height in the center on one side of the card and the word for that numeral printed 1 in. in height on the opposite side of the card. Each student had 4 targeted numerals and corresponding number words. Each student had a laminated index card (5 in x 8 in) with their name printed at the top and circles drawn below which served as token cards. A variety of stickers and small tangibles served as reinforcers. Target stimuli are presented by condition and student in Table 1.

Procedures

General procedures. Students were initially screened to identify unknown numerals, corresponding number words, and control words. The numerals and corresponding number words for each student were matched on stimulus characteristics and assigned to two conditions, called future and nonfuture (described below). Two numerals and corresponding number words were assigned to each student for each condition. Each student in Group A had unique targeted stimuli; students in Group B shared one stimulus in each condition with the remaining stimulus being unique to each student.

The future condition involved (a) instruction with a 3-second constant time delay procedure in naming numerals plus the presentation of the corresponding number word during the consequent events for correct responding; and (b) after criterion level performance was established, direct instruction with a 3-second constant time delay procedure in reading the corresponding number words. The nonfuture condition involved (a) instruction with a 3-second constant time delay procedure in naming numerals, and (b) after criterion level performance was established, direct instruction with 3-second constant time delay procedure in reading the corresponding number words. The future and nonfuture conditions were identical except that during numeral instruction for the future condition the number word was shown to students during the consequent events for correct responses.

Probe procedures. All probe sessions were conducted by the investigator in a 1:1 instructional arrangement. Separate probe sessions were conducted for numerals and words. Both numerals and words were probed in three sessions across three days. For both Group A and Group B, target numeral probe sessions consisted of 4 trials per numeral (16 trials) and an additional 4 trials of a known letter for a total of 20 trials per session. Word probe sessions consisted of 3 trials per number word (12 trials) and 2 trials per control word (8 trials) for a total of 20 trials per session.

In all probe sessions, the following trial sequence was used. The investigator secured the student's attention by stating, "(Student's name), look." and simultaneously holding up the numeral or word card. If the child did not attend, the attentional cue was repeated while the investigator touched the student's arm. When attention had been secured (i.e., child looked at the card), the investigator presented the task direction "What is this?" and provided a 4-second response interval. Correct responses were followed by verbal praise on a CRF schedule and appropriate attending to materials was followed by verbal praise on a VR3 schedule. Errors and no responses were ignored. The intertrial interval was 2-4 seconds in duration. The following sequence was used during probe conditions: (a) Day 1 - observational test of numerals, target/control word probe, target numeral probe, (b) Day 2 - observational test of words, target numeral probe, target/control word probe, and (c) Day 3 - target numeral probe and target control/word probe.

Observational learning probes. Observational learning of both numerals and number words was assessed in a 1:1 instructional arrangement in the form of a pretest, midtest, and posttest. Observational numerals and number words were probed in separate sessions during

the probe conditions as described in the preceding paragraph. For students in Group A, observational tests consisted of two trials per stimulus and 16 trials per session. For students in Group B, observational tests consisted of 5 trials per stimulus and 10 trials per session. The trial sequence was identical to that used during target probes.

Constant time delay. A 3-second constant time delay procedure was used to teach all stimuli. Instructional sessions for Group A and Group B consisted of 6 trials per stimulus and 12 trials per student. A 0-second delay interval was implemented for the first session of each instructional condition. All subsequent sessions employed a 3-second delay interval. If three days elapsed without instruction following the initial 0-second delay session, the 0-second delay trials were repeated for an additional session.

The following trial sequence was used for 0-second instructional sessions. The teacher secured the student's attention by saying, "(Student's name), look." and simultaneously held up the numeral card. If the student did not look, the teacher repeated the verbal cue while touching the student's arm. Once the student looked at the card, the teacher stated the task direction, "What is this?", and immediately presented the controlling prompt (verbal model). After presentation of the controlling prompt, a 3-second response interval was provided followed by the appropriate consequent event, a 2- to 4-second intertrial interval, and the next trial. Correct responses (i.e., imitation of the verbal model) resulted in verbal praise and a slash on the token card. Error and no responses resulted in the teacher telling the student to repeat what she says. The teacher then repeated the controlling prompt. Students selected a tangible reinforcer at the end of the session if they had twelve slashes on the token card.

All sessions following the initial 0-second delay session employed a 3-second delay interval. The trial sequence was identical to the 0-second trials except that a 3-second response interval was inserted between the task direction and delivery of the controlling prompt. Correct responses before and after the prompt received verbal praise and a slash on the token card. Incorrect responses before the prompt received the verbal mand "If you don't know, wait." and removal of the target stimulus followed by the intertrial interval. Incorrect responses after the prompt and no responses resulted in the removal of the target stimulus followed by the intertrial interval and the next trial. If a student had twelve slashes on his token card at the end of the session, he selected a tangible reinforcer. Instruction continued until criterion level responding was established in each condition. Criterion was two consecutive group sessions at 100% CRF and two consecutive group sessions at 100% VR3.

Future numeral condition. In the future condition, correct responses before and after the prompt resulted in verbal praise and a slash on the token card paired with the simultaneous presentation of the corresponding written number word for the targeted numeral. The word was presented for the duration of the verbal praise (approximately 2 seconds). All student statements concerning the presentation of the written word in the consequent event were ignored, and the instructor made no comments about the word.

Nonfuture numeral condition. In the nonfuture condition, correct responses resulted

in verbal praise and a slash on the token card only. The corresponding number word was not presented. On all other variables, the nonfuture condition was identical to the future condition.

Review trials. If all members of a group displayed criterion level performance in one condition prior to the alternate condition, review sessions were conducted for the first condition until performance in the alternate condition reached criterion. During review sessions, each student was presented with one trial of their target stimuli. Review sessions consisted of two trials per student. The trial sequence for review trials was identical to the trial sequence for 3-second delay trials. Reinforcement was thinned from a variable ratio of three trials during the last criterion session to a fixed ratio of two trials.

Number word instruction. Following the second probe condition, constant time delay was implemented to train the corresponding number words to each student. The number words were divided into two sets (future words and nonfuture words), with the trial sequence identical in both conditions and identical to the nonfuture numeral instructional condition. If a student had acquired a word during the numeral training, that word received one review trial per session during number word instruction.

## Experimental Design

An adapted alternating-treatments design (Sindelar et al., 1985) was used to compare the effects of presenting future targeted words in the feedback events and of not presenting the future words in the feedback events. In the adapted alternating-treatments design, two treatments are applied to independent behaviors. It is essential to the design that these behaviors be equal in regard to the level of difficulty. In this investigation, behaviors to be acquired included two sets of numerals and two sets of number words. Targets were chosen for instruction if (a) expressive identification of the numeral was 0% across all trials, (b) match-to-sample of the numeral was 100% across all trials, (c) match-to-sample of the number word was 100% across all trials, and (d) expressive identification of the written word was 0% across all trials. Once the target stimuli were selected, they were counterbalanced across the two instructional conditions (future and nonfuture). Counterbalancing was based upon the topographical similarities of the numerals, number of digits in the numerals, number of letters in the written word, subjects' ability to identify the unknown numeral as a quantity, subjects' ability to rote count to the target number correctly, and subjects' ability to expressively state numerals as quantities in response to tangible objects. Following the selection of target numerals and corresponding number words, a control word was paired with each targeted number word. The following guidelines were used in the selection of the control words: (a) same initial letter, (b) same number of letters (plus or minus one letter on words greater than four letters), (c) topographically similar, (d) not comprised of the same letters (no anagrams), and (e) unknown to the subject. All variables which did not remain constant (e.g. time of day) were counterbalanced and alternated across training sessions to control for both order and sequencing effects.

## Reliability

Procedural reliability data and interobserver agreement data were collected by the investigator and a trained observer across at least 33% of the experimental sessions. A point-by-point method (number of agreements divided by the number of agreements plus the number of disagreements multiplied by 100) was used to calculate inter-observer agreement percentages. Procedural reliability data were calculated by dividing the number of actual teacher behaviors by the number of planned teacher behaviors and multiplying by 100 (Billingsley, White, & Munson, 1980). Data were collected on the following instructor behaviors: presenting the attentional cue, ensuring the child's attention was secured, presenting the task direction, waiting the appropriate response interval, presenting the controlling prompt, providing the appropriate consequent event, presenting the target number word (future condition of numeral instruction only), and waiting the intertrial interval.

# Results

## Interobserver Agreement and Procedural Fidelity

Dependent measure reliability. Interobserver agreement data were collected in 37% of the probe sessions for each student, 37% of the numeral instructional sessions and 36% of the number word sessions for Group A, and 36% of the numeral sessions and 33% of the number word sessions for Group B. The percent of agreement in each session for each student was 100.

Procedural reliability. Procedural reliability data also were collected in 37% of the probe sessions for each student, 37% of the numeral instructional sessions and 36% of the number word sessions for Group A, and 36% of the numeral sessions and 33% of the number word sessions for Group B. Procedural reliability during all probe sessions for all students was 100%. Procedural reliability during all instructional sessions for each teacher behavior was 100% with the following exceptions: (a) for the future numeral condition, the percent of correct implementation for ensuring the attending cue for Chris and Paul was 99 (96-100) and 98 (92-100), respectively, and for presenting the future stimulus for Scott it was 99.7 (97-100); (b) for the nonfuture numeral condition, the percent of providing the task direction for Scott was 99.6 (96-100); (c) for the future number word condition, the percent of providing the task direction for Scott was 99.6 (96-100) and of ensuring the attending cue for Jason was 99 (96-100); and (d) for the nonfuture number word condition, the percent of presenting the attending cue was 99.7 (97-100) and 99 (96-100) for Eric and Paul, respectively.

## Effectiveness

The percent of correct responses for probe and the future and nonfuture numeral and number word conditions are shown in Figures 1, 2, 3, 4 and 5 for Eric, Chris, Scott, Paul, and Jason, respectively. Prior to instruction with constant time delay, no child responded correctly during the Probe I condition on numerals, target number words, or control words. Introduction of training in both conditions (future and nonfuture) for numerals resulted in all

children acquiring the target numerals at criterion levels. Chris was placed in Probe II conditions prior to reaching the group criterion because of the possibility that his mother would remove him from the preschool. No procedural manipulations were necessary for Eric, Chris, Paul, and Jason; however, Eric consistently produced fewer errors in the first daily session regardless of the instructional condition (i.e., future or nonfuture). Two procedural manipulations were necessary for Scott. On the 20th session, differential reinforcement for correct unprompted responses was instituted; unprompted correct responses resulted in praise and delivery of a token, and prompted correct responses resulted in praise. This modification resulted in 100% unprompted correct responses in the future but not nonfuture condition. Thus, a match-to-sample attending response was introduced in both conditions and resulted in criterion level performance. For numerals for all students, 100% correct performance occurred in the Probe II condition.

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Insert Figures 1, 2, 3, 4, and 5 about here

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As noted above, none of the students responded correctly to the number words in the Probe I condition. During Probe II, three sessions on all target behaviors occurred before spring break and one after spring break. No student responded correctly to the nonfuture number words or to any of the control words. During the first three sessions of Probe II, Eric responded correctly to both future number words (i.e., those presented during the feedback events during numeral instruction). Following spring break, he responded correctly to all trials of one number word from the future condition and none of the trials for the second word. During the first three sessions of Probe II, Chris responded incorrectly in the first session to all number words; during the second session with future number words, he was correct on 67% of the trials (i.e., all trials for one word and one trial for the second word); and during the third session, he responded correctly on 50% of the trials (i.e., all trials for one word). After a two week absence, he responded correctly to none of the words in the fourth Probe II session. Scott did not respond correctly to any number words during Probe II. Paul responded correctly to one future number word during the first session of Probe II, but thereafter responded incorrectly to all number words. Jason did not respond correctly to any of the number words during Probe II.

After Probe II, constant time delay training was implemented for all target number words (future and nonfuture). For Eric, the one number word to which he always responded correctly during Probe II sessions was given only one trial interspersed with instructional trials on his second word. However, during the first five sessions, he did not maintain correct performance on the previously acquired number word; therefore, the number of trials for that word was increased to six per session. As a result, he acquired all words at criterion levels. During Probe III, Eric maintained 100% correct performance on all numerals and target number words, and performed at 0% correct on all control words. Chris met criterion on all number words without modification of procedures. During Probe III, he was 100% correct on all numerals and target number words and had 0% correct performance on control words. For Scott, procedural modifications were required during number word instruction. These included a match to sample attending response as used with numerals. However,

errors continued on two number words, one from each condition. The match to sample attending cue was modified to use these two numerals (in both conditions) as the distractor. Finally, differential reinforcement was used for unprompted and prompted correct responses. These modifications resulted in Scott achieving criterion level performance in the future number word condition, but not in the nonfuture condition. Instruction was stopped due to the end of the school year. However, during Probe III, Scott responded at 100% correct responses for all target words and numerals and responded at 0% correct on all control words. Paul and Jason achieved criterion level performance in both number words conditions without procedural modifications. Their Probe III performance was 100% correct responding to all numerals and target number words and 0% correct on all control words.

Efficiency

A primary purpose of the study was to determine whether the presentation of number words during the feedback events of numeral instruction would influence the rapidity of learning the number words. Data on the number of sessions, the number and percent of errors, and the number of minutes of instruction through criterion for numeral and number word instruction for the two conditions (future and nonfuture) are shown in Table 2.

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Insert Table 2 about here

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As shown in Table 2, the number of sessions to group criterion for numeral instruction in the future and nonfuture conditions were equivalent. Similarly, the number of minutes of instruction were similar. The mean session length for the numeral future condition was 5 minutes, 13 seconds; the mean session length for the numeral nonfuture condition was 5 minutes, 9 seconds. These data indicate that the addition of the number word during feedback events for correct responding did not increase the number of sessions to criterion and did not increase substantially the length of the sessions.

When instruction was implemented for the number words, all five students acquired the number words in the future condition (i.e., those that had been presented in the feedback events during numeral instruction); but only four of the five students acquired the number words in the nonfuture condition. Scott, the student who did not acquire the number words in the nonfuture condition, however, did respond correctly to the number words in the final probe condition. Thus, his data are included in the analysis of the rapidity of learning. In terms of sessions to criterion, all students required fewer sessions to criterion in the future condition as compared to the nonfuture condition. Summed across students, the future condition required 77 sessions and the nonfuture 89 sessions. Similar differences were found for the number of minutes of instruction. Four of the five students required fewer minutes of instruction in the future word condition than in the nonfuture word condition; for the fifth student, Chris, the number of minutes were equivalent. Summed across students, the future condition required 309 minutes of instruction, and the nonfuture condition required 377 minutes of instruction. The mean session length for the future condition was 4 minutes, and the mean session length for the nonfuture condition was 4 minutes and 15 seconds. Thus,

based on the data presented in Table 2, it appears that the presentation of the number words during feedback events for correct responding during numeral instruction decreased the number of sessions and minutes needed to reach criterion when words were taught directly. Interestingly, for the students who met criterion in all conditions, the number of sessions and number of minutes of instruction to criterion were less for the word condition than for the numeral condition. This was true across both future and nonfuture conditions.

Observational Learning

During each probe condition, students were individually assessed on expressive naming of the other group members' target numerals and number words. Observational numerals and number words were assessed in one separate probe session per probe condition. These probes were referred to as pretest (Probe I condition), midtest (Probe II condition), and posttest (Probe III condition).

The percentages of correct responses for observational learning of numerals are shown in Table 3. During the pretest, Eric, Chris, and Paul responded correctly to the numerals taught to their peers. The midtest data indicate that Eric, Chris, and Jason acquired their peers' target numerals; however, this was not differentially affected by the future or nonfuture conditions. Eric, Chris, Paul, and Jason maintained 100% correct responding on all observational numerals during the posttest. Scott did not respond correctly to any observational numerals during the posttest.

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Insert Table 3 about here

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The percent of correct responses for observational learning of number words also are shown in Table 3. During the pretest, no student responded correctly to the number words. During the midtest, Eric responded correctly to 50% of the number words in the future condition (i.e., those shown to his peers during feedback events for correct responding during the numeral instruction). None of the other students responded correctly during the midtest. During the posttest, Eric responded correctly to 50% of the number words from the future condition, and 25% of the number words in the nonfuture condition. Chris responded correctly to 50% of the number words from the future condition, and none in the nonfuture condition. Scott did not respond correctly to any of the words in the posttest; Paul responded correctly to all words in the posttest; and Jason responded correctly to all the future words but none of the nonfuture words. These data provide tentative support for the notion that the future condition produced greater observational learning of the number words for at least three of the students.

## Discussion

This study assessed the effects of presenting number words in the consequent event for numeral instruction on acquisition of both numerals and number words. Based on the results several findings merit discussion. First, implementation of constant time delay

resulted in all five students learning to expressively identify numerals and four of five students learning to expressively identify number words. For the fifth student, the end of the school year prevented criterion being met in the nonfuture condition; however, this student performed at 100% on the final number word probe suggesting that all behaviors were essentially learned. In addition, behaviors were acquired although no student had a history with constant time delay or any direct instructional strategy.

Second, number words were acquired more efficiently than numerals suggesting that learning to learn may have occurred. Nonfuture numerals were acquired in 108 sessions while nonfuture number words were acquired in 89 sessions across all subjects. Additionally, future numerals were acquired in 108 sessions and future number words were acquired in 77 session across all subjects. This is similar to other studies (e.g., Godby, Gast, & Wolery, 1987); although, it is difficult to document in this study because of differences between the stimuli (numerals and number words).

Third, addition of the number word to the consequent event during future numeral instruction did not interfere with acquisition of the numerals. This is consistent with findings of previous research (Wolery, Doyle, et al., 1991). In three of five students, number and percentage of errors through criterion were lower in the future condition. Future numeral instruction resulted in 8 additional minutes (i.e. mean of 4 seconds per session) of instructional time across all subjects and sessions.

Fourth, the addition of the number word to the consequent event for numeral instruction resulted in more rapid learning (i.e., sessions and minutes through criterion) of number words. Future number words required 87% of the sessions needed to acquire the nonfuture number words. Thus, if one session were conducted each day, the teacher would gain an extra session for teaching some other skill every two weeks. Similarly, the future number words required 82% of the minutes of instruction needed to acquire the nonfuture number words. This represents a savings of slightly more than 10 minutes for every hour of direct instruction. Thus, for each 6-hours of direct instruction, a savings of one hour would accrue. Such differences constitute considerable savings of instructional time for other activities. It should be noted that the apparent increase in observational learning as a result of including the number word in the numeral instruction was not calculated into these figures. Thus, the savings represented by the manipulation may be greater than reported.

Finally, observational learning occurred for both numerals and number words in some students. The addition of the number word to the consequent event for numeral instruction may increase observational learning of number words when they are directly taught. For three of the five students observational learning of future number words was greater than learning of nonfuture number words. For the remaining two students there were no differences between the two conditions. Differences between observational learning in the two procedures deserves further investigation.

Based on the findings of this study and those of Wolery, Doyle, et al. (1991), tentative support exists for recommending that teachers present future target stimuli during current instruction. The addition of the future target stimuli does not appear to interfere with

the acquisition of the behaviors currently being taught, but does appear to result in more rapid learning of those stimuli when they are subsequently taught.

In continuing this line of research at least four issues deserve attention. First, the effects of this intervention should be investigated with additional students with more varied tasks. To date, the effects of adding future target stimuli to current instruction has been studied only with naming photographs and reading words corresponding to those photographs (Wolery, Doyle, et al., 1991) and naming numerals and reading words corresponding to those numerals (i.e., this study). The effects of this manipulation on other types of behaviors deserves immediate research attention.

Second, the effects of calling attention to the stimulus that is presented in the feedback events should be studied. For example, the teacher could say, "this is also (number)" during the praise statement; or, the number words could be presented in highly varied formats (e.g., different colors, sizes, and on different backgrounds). Such studies should determine whether these manipulations interfere with the acquisition of the behaviors being taught and whether they differentially influence the rapidity of future learning.

Third, the use of specific and group attending cues should be investigated. In this study, a general attending cue was required only of the student receiving the trial (i.e., the student was asked to look at the card). However, Wolery, Cybriwsky, Gast, and Boyle-Gast (1991) found that specific attending cues/responses increased the amount of observational and incidental learning; and Wolery et al. (1990) found that group attending responses increased observational learning. Additional research should evaluate the effects of these variations on the amount of observational learning that occurs for the behaviors being directly taught to peers and the stimuli presented in the feedback events for peers.

Fourth, future research should focus on using this manipulation repeatedly across sets of stimuli. For example, during instruction on numeral naming (i.e., as in this study), the number word could be presented in the feedback events. During subsequent direct instruction on word reading, students could be told the sequence of letters in the feedback events (i.e., for teaching spelling) (cf. Gast, Doyle, Wolery, Ault, & Baklarz, 1991). During subsequent direct instruction on spelling, students could be shown coins whose values equaled the word being spelled. Such studies would allow the manipulation to be evaluated when it is used repeatedly.

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Table 1

Student Demographics, Target Behaviors and Control Behaviors by Instructional Condition

| Group Child | CA[a] | Disability | Developmental Ages | | | | | | | Target Behaviors and Control Behaviors | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | SC[b] | AD[b] | MT[b] | CM[b] | CG[b] | RL[c] | EL[c] | Future[d] | Nonfuture[d] |
| Group A | | | | | | | | | | | |
| Eric | 54 | Developmental/ Language Delay | 52 | 51 | 50 | 41 | 55 | 60 | 53 | 11-eleven/elect<br>15-fifteen/flicker | 12-twelve/tither<br>17-seventeen/somewhere |
| Chris | 56 | Developmental/ Language Delay | 54 | 49 | 53 | 33 | 53 | 39 | 39 | 2-two/toe<br>9-nine/near | 5-five/fawn<br>10-ten/tie |
| Scott | 55 | Developmental/ Language Delay | 37 | 45 | 47 | 43 | 42 | 41 | 52 | 1-one/our<br>7-seven/seems | 4-four/fear<br>6-six/sea |
| Group B | | | | | | | | | | | |
| Paul | 42 | Developmental/ Language Delay | 31 | 24 | 30 | 27 | 41 | 42 | 37 | 6-six/sea<br>11-eleven/elect | 9-nine/near<br>12-twelve/tither |
| Jason | 60 | Seizure Disorder/ Developmental/ Language Delay | 38 | 35 | 43 | 43 | 36 | 54 | 43 | 6-six/sea<br>4-four/fear | 9-nine/near<br>2-two/toe |

[a] CA = Chronological Age.
[b] Developmental Age scores were derived from the Batelle Developmental Inventory (Newborg, Stock, Wnek, Guidubaldi, & Svinicki, 1984). SC = Social, AD = Adaptive, MT = Motor, CM = Communication, CG = Cognitive.
[c] Developmental age scores were derived from the Preschool Language Scale (Zimmerman, Steiner, & Pond, 1979).
[d] Target numeral, corresponding target number words, and control word.



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Table 2

Number of Sessions, Number and Percent of Errors, and Minutes of Direct Instruction Through Criterion

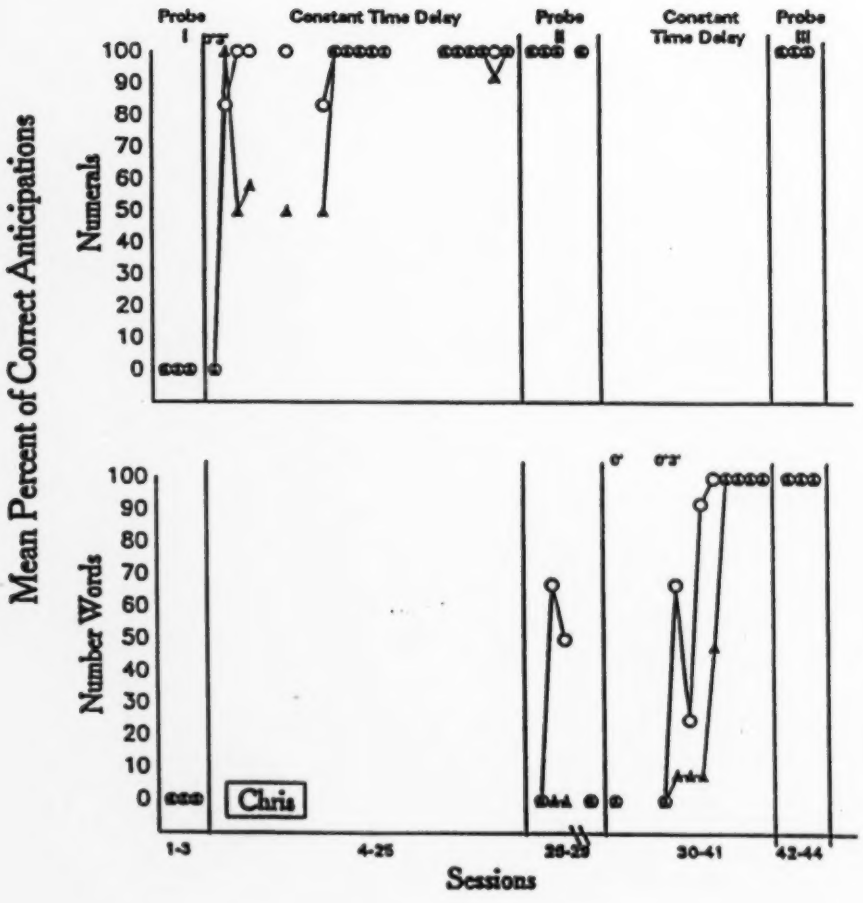
| Stimuli | Number of Sessions | | Number of Errors | | Percent of Errors | | Minutes of Instruction | |
|---|---|---|---|---|---|---|---|---|
| Student | Future | Nonfuture | Future | Nonfuture | Future | Nonfuture | Future | Nonfuture |
| Numerals | | | | | | | | |
| Eric | 31 | 31 | 14 | 22 | 3.8 | 5.9 | 174 | 171 |
| Chris | 17 | 17 | 1 | 10 | 0.5 | 4.9 | 109 | 104 |
| Scott | 32 | 32 | 14 | 28 | 3.7 | 7.3 | 178 | 175 |
| Paul | 17 | 17 | 0 | 0 | 0.0 | 0.0 | 57 | 59 |
| Jason | 11 | 11 | 0 | 1 | 0.0 | 0.7 | 46 | 47 |
| Total | 108 | 108 | 29 | 61 | 2.2 | 4.7 | 564 | 556 |
| Number Words | | | | | | | | |
| Eric | 12 | 15 | 4 | 4 | 3.2 | 2.2 | 55 | 81 |
| Chris | 11 | 12 | 0 | 4 | 0.0 | 3.3 | 52 | 58 |
| Scott* | 29 | (32) | 8 | (16) | 2.3 | (4.4) | 126 | (146) |
| Paul | 12 | 15 | 0 | 0 | 0.0 | 0.0 | 37 | 46 |
| Jason | 13 | 15 | 1 | 1 | 0.6 | 0.5 | 39 | 46 |
| Total | 77 | 89 | 13 | 25 | 1.4 | 2.3 | 309 | 377 |
| GRAND TOTAL | 185 | 197 | 42 | 86 | 1.9 | 3.6 | 873 | 933 |

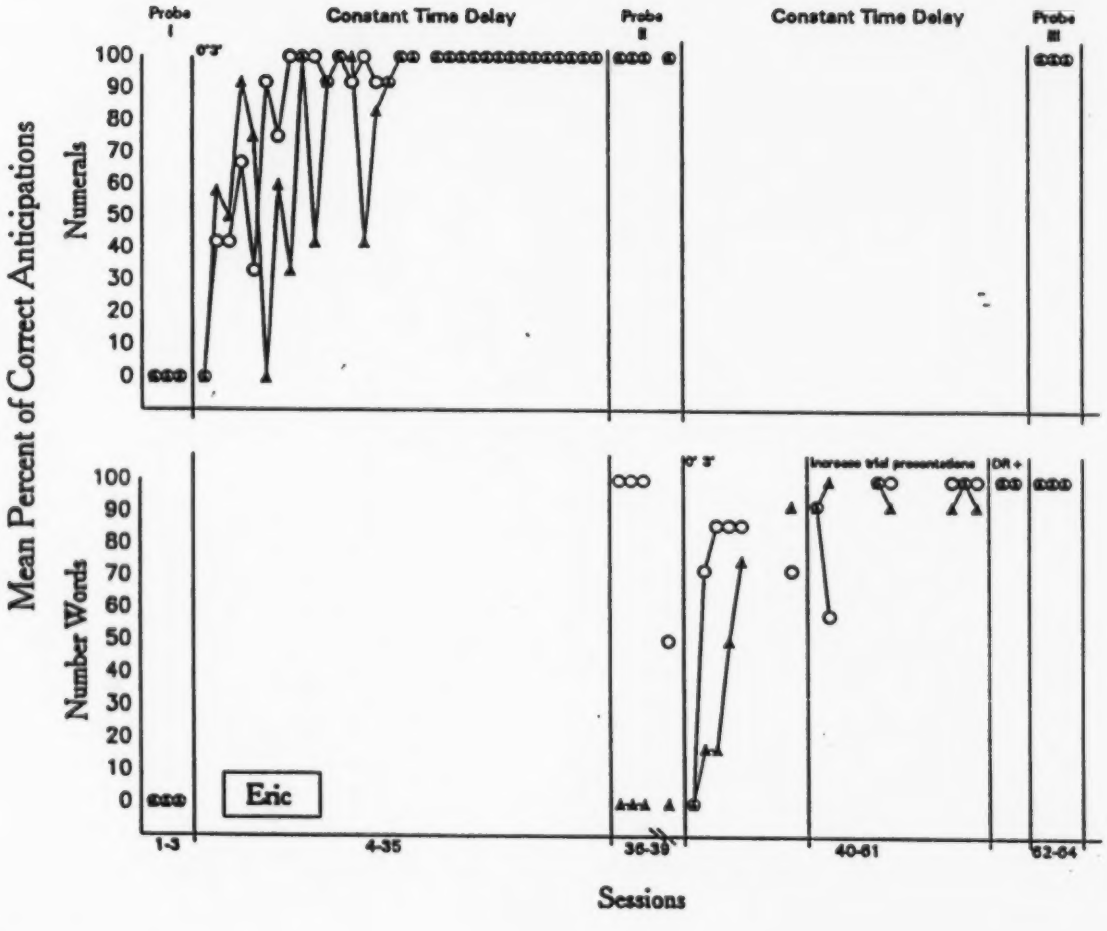
* Scott did not reach criterion in the nonfuture number word condition; however, he responded correctly on all trials during Probe III following instruction.

Table 3

Percent of Correct Responses on Observational Numerals and Number Words by Probe Conditions and Subjects

| Student | % Correct Responses of Numerals | | | % Correct Responses of Number Words | | |
|---|---|---|---|---|---|---|
| Condition | Pretest | Midtest | Posttest | Pretest | Midtest | Posttest |
| Eric | | | | | | |
| Future | 75 | 100 | 100 | 0 | 50 | 50 |
| Nonfuture | 100 | 100 | 100 | 0 | 0 | 25 |
| Chris | | | | | | |
| Future | 50 | 100 | 100 | 0 | 0 | 50 |
| Nonfuture | 50 | 100 | 100 | 0 | 0 | 0 |
| Scott | | | | | | |
| Future | 0 | 0 | 0 | 0 | 0 | 0 |
| Nonfuture | 0 | 0 | 0 | 0 | 0 | 0 |
| Paul | | | | | | |
| Future | 100 | 100 | 100 | 0 | 0 | 100 |
| Nonfuture | 100 | 100 | 100 | 0 | 0 | 100 |
| Jason | | | | | | |
| Future | 0 | 100 | 100 | 0 | 0 | 100 |
| Nonfuture | 0 | 100 | 100 | 0 | 0 | 0 |


Mean Percent of Correct Anticipations
Probe I
Constant Time Delay
Probe II
Constant Time Delay
Probe III
Numerals
Number Words
100
90
80
70
60
50
40
30
20
10
0
Chris
1-3
4-25
28-29
30-41
42-44
Sessions


Probe I
Constant Time Delay
Probe II
Constant Time Delay
Probe III
0" 3"
Numerals
Number Words
100
90
80
70
60
50
40
30
20
10
0
Increase trial presentations
DR +
Eric
1-3
4-35
36-39
40-61
62-64
Sessions
Mean Percent of Correct Anticipations

## Figure Captions

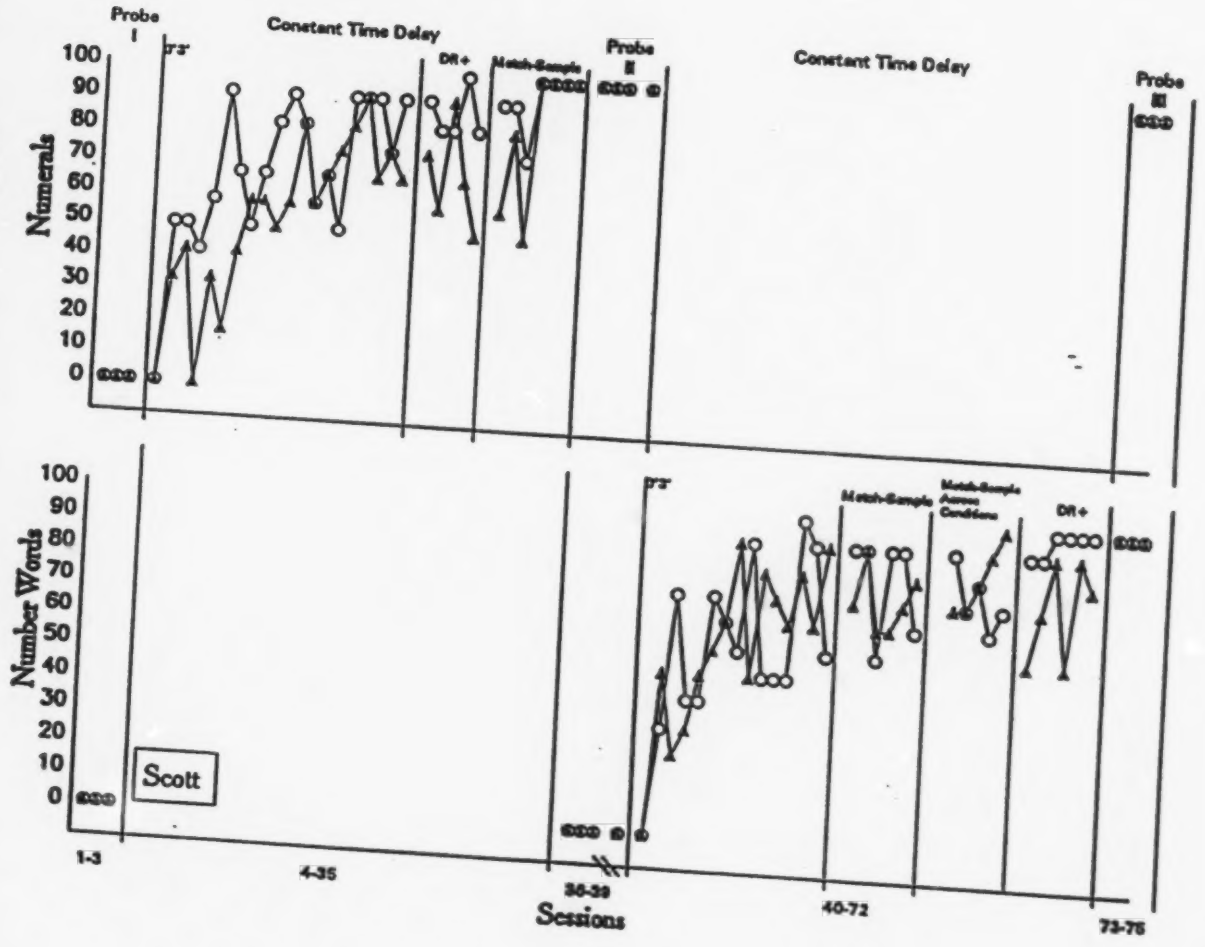
Figure 1. The percent of correct anticipations of future stimuli (open circles) and nonfuture stimuli (closed triangles) for Eric during probe and instructional conditions.

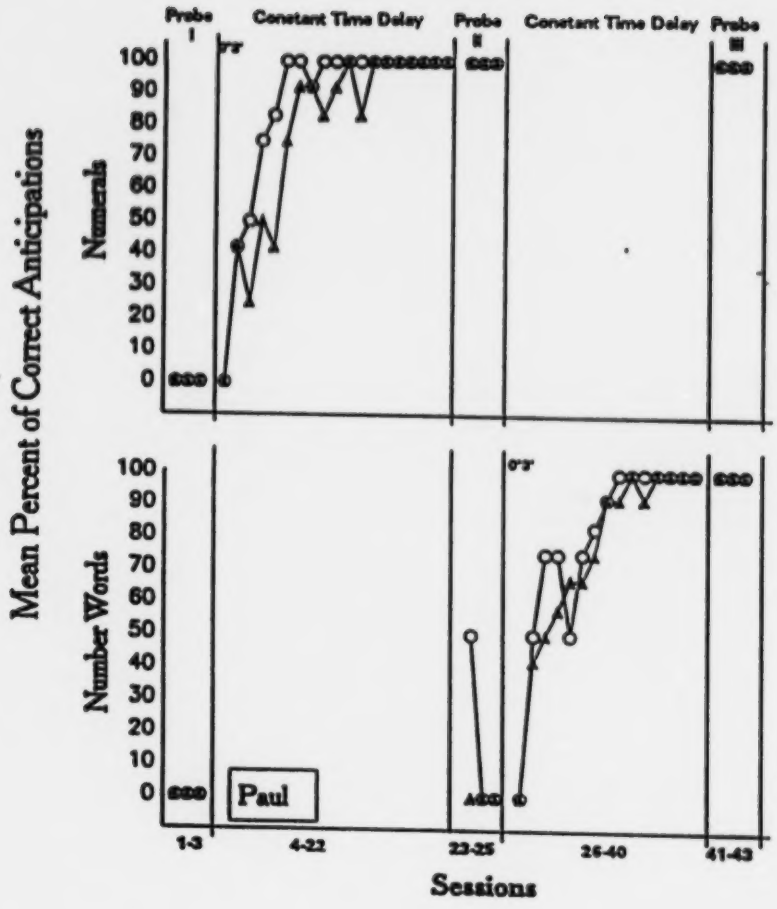
Figure 2. The percent of correct anticipations of future stimuli (open circles) and nonfuture stimuli (closed triangles) for Chris during probe and instructional conditions.

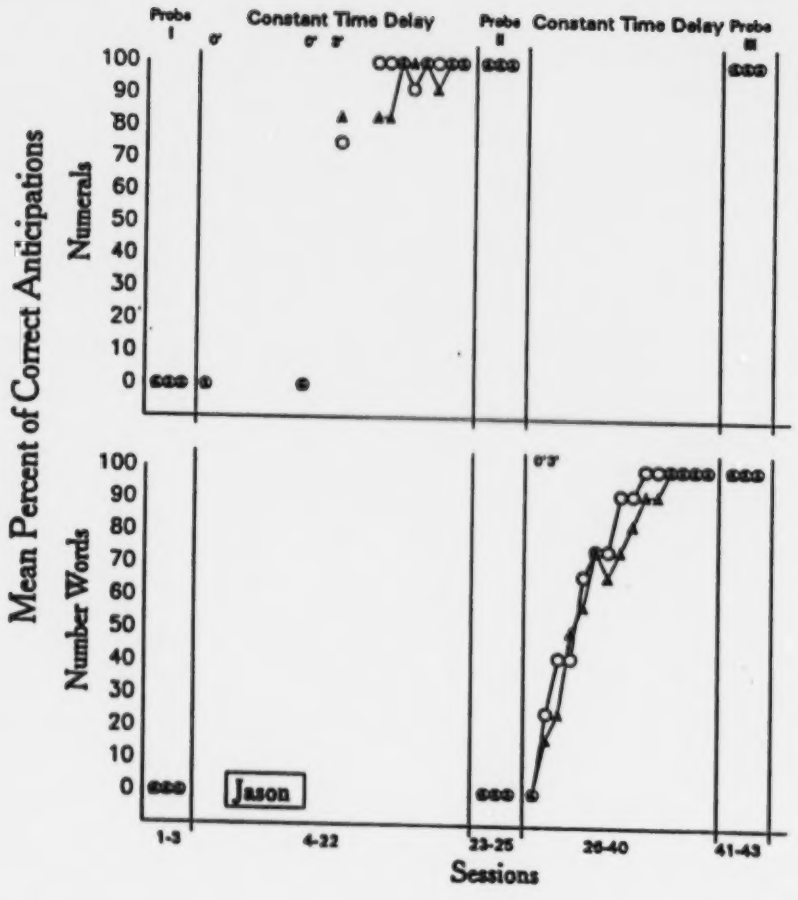
Figure 3. The percent of correct anticipations of future stimuli (open circles) and nonfuture stimuli (closed triangles) for Scott during probe and instructional conditions.

Figure 4. The percent of correct anticipations of future stimuli (open circles) and nonfuture stimuli (closed triangles) for Paul during probe and instructional conditions.

Figure 5. The percent of correct anticipations of future stimuli (open circles) and nonfuture stimuli (closed triangles) for Jason during probe and instructional conditions.


Mean # Given of Correct Responses
Probe I
Constant Time Delay
DR+
Match-Sample
Probe II
Constant Time Delay
Probe III
Numerals
Number Words
Scott
1-3
4-35
36-39
40-72
73-75
Sessions


Probe I
Constant Time Delay
Probe II
Constant Time Delay
Probe III
Numerals
Number Words
Mean Percent of Correct Anticipations
100
90
80
70
60
50
40
30
20
10
0
Paul
1-3
4-22
23-25
26-40
41-43
Sessions


Probe I
Constant Time Delay
Probe II
Constant Time Delay
Probe III
0"
0" 3"
0"3"
Mean Percent of Correct Anticipations
Numerals
Number Words
100
90
80
70
60
50
40
30
20
10
0
Jason
1-3
4-22
23-25
26-40
41-43
Sessions